



Patent
Attorney's Docket No. 018775-795

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT
APPLICATION TRANSMITTAL LETTER



Box **PATENT APPLICATION**
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed for filing is the utility patent application of Hiroki YOSHIDA for IMAGE PROCESSING FOR IMAGE CORRECTION.

Also enclosed are:

- ☒ 6 sheet(s) of ☒ formal ☐ informal drawing(s);
- ☒ a claim for foreign priority under 35 U.S.C. §§ 119 and/or 365 is ☐ hereby made to _
filed in _ on _;
☒ in the declaration;
- ☐ a certified copy of the priority document;
- ☐ a General Authorization for Petitions for Extensions of Time and Payment of Fees;
- ☐ _____ statement(s) claiming small entity status;
- ☐ an Assignment document;
- ☐ an Information Disclosure Statement; and
- ☒ Other: _____.
- ☒ An ☐ executed ☒ unexecuted declaration of the inventor(s)
☒ also is enclosed ☐ will follow.
- ☐ Please amend the specification by inserting before the first line the sentence --This application claims priority under 35 U.S.C. §§119 and/or 365 to _ filed in _ on _; the entire content of which is hereby incorporated by reference.--
- ☐ A bibliographic data entry sheet is enclosed.



21839

☒ The filing fee has been calculated as follows ☐ and in accordance with the enclosed preliminary amendment:

CLAIMS					
	NO. OF CLAIMS		EXTRA CLAIMS	RATE	FEE
Basic Application Fee					\$690.00 (101)
Total Claims	20	MINUS 20 =	-0-	x \$18.00 (103)	-
Independent Claims	3	MINUS 3 =	-0-	x \$78.00 (102)	-
If multiple dependent claims are presented, add \$260.00 (104)					-
Total Application Fee					\$690.00
If verified Statement claiming small entity status is enclosed, subtract 50% of Total Application Fee					-
Add Assignment Recording Fee if Assignment document is enclosed					-
TOTAL APPLICATION FEE DUE					\$690.00

☐ This application is being filed without a filing fee. Issuance of a Notice to File Missing Parts of Application is respectfully requested.

☒ A check in the amount of \$ 690.00 is enclosed for the fee due.

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Please address all correspondence concerning the present application to:

PLATON N. MANDROS
Burns, Doane, Swecker & Mathis, L.L.P.
P.O. Box 1404
Alexandria, Virginia 22313-1404.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

Date: June 28, 2000

By: 

Platon N. Mandros
Registration No. 22,124

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

IMAGE PROCESSING FOR IMAGE CORRECTION

This application is based on application No. 11-183444 filed in Japan, the contents of which are hereby
5 incorporated by reference.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to image correction
10 of digital image.

DESCRIPTION OF PRIOR ART

When digital image data received from a digital
camera or the like are corrected, if a person is included in
the image, the skin color has to be corrected accurately
15 because skin color is a memory color. In prior art image
processing, skin area or person area is extracted generally
by using color information. For example, in the skin image
recognition described in Japanese Patent laid open
20 Publication 6-309433/1994, skin area candidates are searched
from LHC data converted from RGB data, and a histogram on
lightness is obtained. Then, an indication on closeness to
skin is calculated from the histogram, and skin areas are
determined based on the indication. In hand recognition
25 described in Japanese Patent laid open Publication 7-

105371/1995, a skin pixel is detected in an image of hand when color components of the pixel are within a predetermined range, and a skin area is extracted in the image of hand. In skin area detection described in Japanese Patent laid open Publication 9-44670/1997, a histogram of hue converted from RGB data is obtained, and a face area is detected in a particular distribution range in the hue histogram. In person detection apparatus described in Japanese Patent laid open Publication 9-50528/1997, a face area is searched in RGB data, and a person area is divided to mosaics to extract a face area.

However, in the prior art image correction techniques, when skin color is extracted from the image and corrected, the image correction is performed on the entire image uniformly, and color correction is performed generally without limiting to skin. Therefore, when an image includes a plurality of persons having different skin characteristics, it is difficult to perform appropriate correction for each skin.

SUMMARY OF THE INVENTION

An object of the present invention is to provide appropriate image correction by taking each skin characteristic into account even when an image includes a plurality of persons having different skin characteristics.

Another object of the present invention is to provide image correction which can detect skin color fast in an image.

In one aspect of the invention, in the image processing

An advantage of the present invention is that even when an image includes a plurality of persons having different skin characteristics, correction appropriate for each skin type is possible.

Another advantage of the present invention is that skin areas can be extracted at high speed.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, and in which:

Fig. 1 is a diagram of an entire image processor;

Fig. 2 is a block diagram of a controller and thereabout;

Fig. 3 is a general flowchart of skin color correction;

Fig. 4 is a flowchart of skin color correction;

Fig. 5 is a diagram of an example of hue histogram concretely;

Fig. 6 is a diagram of an example of modification of the hue histogram;

5 Fig. 7 is a diagram of an example of chroma histogram;

Fig. 8 is a diagram of an example of modification of the chroma histogram; and

10 Fig. 9 is a diagram of an example of generation of correction curve.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, Fig. 1 shows an entire image processing apparatus according to a first embodiment of the invention. It has a controller (computer) 1 which controls the entire apparatus, as a central component. In Fig. 1, arrows show directions of data flow. A display device 2
15 displays various screens provided for operation or image processing as well as an image in a screen. A keyboard 3 and a mouse 4 are used for various inputs and instructions by a user. A flexible disk 5 and a hard disk 6 are storage media for storing, for example, image data, attribute
20 information and programs. The apparatus has a flexible disk
25

drive and a hard disk drive for accessing the flexible disk 5 and the hard disk 6. A printer 7 prints image data or the like on a paper. A scanner 8 reads image data of a document. A CD-ROM 9 is a storage medium for storing various data or programs, and the apparatus has a CD-ROM drive for accessing the CD-ROM 9. Programs explained later are read from an external recording medium such as a CD-ROM.

Fig. 2 is a block diagram of the controller 1 and thereabout. The controller 1 has a central processing unit (CPU) 210 connected via a bus 220 to a read-only-memory (ROM) 203 for storing various programs and a random access memory (RAM) for storing various data and programs. Further, it is also connected via the bus 220 to a display controller 205 for displaying images and characters in a screen of the display apparatus 2, a keyboard controller 206 for controlling key-input from the keyboard 3, a mouse controller for controlling an input from the mouse 4, a flexible disk controller 208 which controls the flexible disk drive, a hard disk controller 209 for controlling the hard disk 6, a printer controller 210 which controls outputs to the printer 7, a scanner controller 211 which controls the scanner 8, and a CD-ROM drive controller 212 which controls the CD-ROM drive. Further, in the controller, a clock circuit 202 generates various clock signals for operating the apparatus. Further, extension slots 215 are

connected to the bus 220 for connecting various extension boards to which for example a SCSI board is connected for connecting a flexible disk drive, a hard disk drive, a scanner, a CD-ROM drive or the like. Further, it is also
5 connected via an interface card to a network (web). In this apparatus, the flexible disk 5 and the hard disk 6 are used as storage media, but other medium such as a magneto-optical disk may also be used. The scanner 8 and the CD-ROM 9 are used for inputting image data, but another input devise such
10 as a still video camera may also be used. The printer 7 is used as an output device, but a digital copying machine or the like may also be used.

In this apparatus, image data are corrected in an image correction routine which includes extraction and
15 correction of skin color areas. When start of image correction is instructed by a user, the routine is evoked. The image correction routine further includes image file input/output processing, image data display processing, a graphic user interface processing for image correction
20 operation, error processing in the graphic user interface processing, and resolution change processing, but they are not explained here.

In the image correction, even when an image includes a plurality of persons having different skin
25 characteristics, skin is corrected by taking each skin

characteristic into account. Various types of skin areas have been classified beforehand for each skin characteristic. When image data are received, skin areas are extracted from the image data according to the skin type, and the image data are corrected appropriately by taking the skin characteristics of skin areas into account.

Table 1 compiles correction for each skin type wherein skin type is classified into white, yellow and tan. In the case of white, hue histogram is extended to shift center of gravity in a direction of skin color of memory color (pink), and chroma histogram is extended in a direction of standard chroma. In the case of yellow, hue histogram is extended to shift center of gravity in a direction of skin color of memory color, and chroma histogram is extended in a direction of high chroma. In the case of tan, hue histogram is extended to shift center of gravity in a direction of skin color of memory color (orange), and chroma histogram is extended in a direction of low chroma. As explained above, skin types are classified, and skin image is corrected according to the characteristic of skin type by modifying the histograms. Then, even when an image includes different skin types, each skin type can be corrected appropriately.

Table 1 Image correction according to skin type

Skin type	Correction	
	Hue	Chroma
White	Extend histogram to shift center of gravity in a direction of memory color (pink)	Shift center of gravity in a direction to standard chroma (center value of chroma), and extend histogram
Yellow	Extend histogram to shift center of gravity in a direction of memory color	Shift center of gravity in a direction to high chroma and extend histogram
Tan	Extend histogram to shift center of gravity in a direction of memory color (orange)	Shift center of gravity in a direction to low chroma and extend histogram

Fig. 3 shows a flowchart of skin correction in the image correction. First, skin color is extracted from input image data. The input image data is converted from RGB signals to HSL signals (step S10), and skin candidate areas are extracted roughly from the RGB signals of the input image data (step S12). Next, HSL signals in the extracted skin candidate areas are converted to Lab signals (step S14), and skin areas are extracted carefully from data of ab (hue) (step S16). Because skin is extracted in the above-

mentioned two steps, skin areas can be extracted together from the image at high precision and at high speed, and the image extraction has no dropping out on skin area.

Next, skin is corrected. First, histograms of hue and chroma are prepared for each of the extracted skin areas (step S18). Next, an average, a dispersion and a center of gravity are calculated from the histograms and skin characteristic is classified based thereon (step S20), and the forms of histograms are modified (step S22). Next, a correction curve for correcting input data to generate output data is determined according to the adjusted histograms (step S24), and the skin color is corrected by using the correction curve (step S26).

Fig. 4 shows a flow chart of skin correction concretely. First, image data (RGB signals) are received (step S100), and the image data are divided into rectangles (or a mosaic image) (step S102). Next, the input RGB signals are converted to HSL signals (step S104).

Next, skin color is extracted from the image data. First, skin candidate areas are extracted coarsely from hue (H) signals for each rectangle (Step S106). In this extraction, a range of hue to be detected is limited, so as to detect generally all types of skin. However, skin type cannot be specified. Next, HSL signals are converted to Lab signals only on the extracted skin candidate areas (step

S108). Next, the skin candidate areas are extracted finely according to the a, b signals for each rectangle (step S110). That is, skin type is specified from the signals ab to extract skin candidate areas. In this skin extraction, in the first step, the processing is simple and coarse, and in the second step, the processing is heavy but fine. Then, the extraction can be performed at high speed. Next, the images are divided into skin areas (step S112), wherein the skin candidate areas obtained in the unit of rectangle are integrated for each skin type specified above. In the integration, a differences of the a, b signal is compared between adjacent rectangles and compared with a threshold determined for skin type, and if the a, b signals are within the thresholds, the adjacent rectangles are integrated.

Next, skin is corrected. First, histograms of hue and chroma are prepared for each of the skin areas which have been extracted and integrated above (step S114). Next, in order to determine the skin characteristic, an average, a dispersion and center of gravity are calculated from the histograms (step S116). Next, processing shown in Table 1 is performed for each area. First, skin type is classified (step S120). Then, the histogram of hue is extended to shift the center of gravity in a direction of skin color of memory color according to the skin type, and the histogram of chroma is extended in a direction according to the skin

type, based on the average, dispersion and center of gravity of the histograms (step S122). Next, correction curves are determined on hue and chroma (step S124), and skin image is corrected by using the correction curves (step S126). Next,
 5 it is decided whether a next area to be processed is remained (step S128). If there is a next area, the flow returns to step S116, and the above skin correction is repeated. If there is no next area, the processing is completed.

10 An example of the processing on the histogram of hue is explained with reference to Figs. 5 and 6. Fig. 5 shows a histogram of hue in a skin area. In the histogram, center of gravity is shifted from "A" (white circle) to "B" (black circle) of memory color of skin color according to
 15 skin type, and as shown in Fig. 6, the width "a" is increased to "b".

Fig. 7 shows a histogram of chroma for skin type of white in a skin area. As shown in Fig. 8, the histogram is subjected to the correction explained above with
 20 reference to Table 1, wherein the center of gravity is shifted in a direction of standard chroma (center of chroma) and the histogram is extended.

With reference to the modification of the histogram, as shown in Fig. 9, a correction curve for
 25 correcting input data to output data is determined (as

explained on step S124). The correction curve is prepared by accumulating the frequencies of the histogram of chroma from the low level to high level.

Although the present invention has been fully
5 described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the
10 scope of the present invention as defined by the appended claims unless they depart therefrom.

WHAT IS CLAIMED IS:

1. An image processor, wherein characteristics of a plurality of skin colors are classified beforehand, comprising:

5 an area extractor which extracts skin areas from input image data according to the classification of the characteristics of a plurality of skin colors; and

an image corrector which corrects image data of each of the skin areas extracted by said area extractor according to the characteristics of the skin color of the each of the skin areas.

10 2. The image processor according to claim 1, wherein said area extractor determines the characteristic of skin according to average, dispersion and center of gravity obtained from a histogram of image data of each of the skin areas.

15 3. The image processor according to claim 1, wherein said image corrector prepares a histogram of hue for each of the skin areas extracted by said image extractor, modifies the histogram to shift the center of gravity thereof to come close to center of gravity of a memory color of the skin color according to the characteristic of skin color of the each of the skin areas, generates a correction curve for correcting the image data according to the modified
20 histogram, and corrects the image data in the skin area
25

according to the correction curve.

4. The image processor according to claim 3, wherein said image corrector prepares a histogram of chroma for each the skin areas extracted by said image extractor, modifies the histogram according to the characteristic of skin, and generates a correction curve for the image data in the skin area.

5. The image processor according to claim 4, wherein when the skin areas are extracted from the input image data, said area extractor extracts skin candidate areas from image data, converts color specification system of the image data for each of the skin candidate areas and extracts skin areas from the skin candidate areas based on the image data in the color specification system.

6. The image processor according to claim 5, wherein said area extractor comprises a divider which divides the image data into rectangle areas, and an area integrator which integrates the rectangle areas for each of the characteristic when the skin areas are extracted, wherein said area integrator integrates adjacent pixels if difference in hue between adjacent pixels is within a threshold determined for each skin type.

7. The image processor according to claim 1, wherein said image corrector prepares a histogram of chroma for each of skin areas extracted by said image extractor, modifies

the histogram according to the characteristic of skin, and generates a correction curve for correcting the image data.

8. The image processor according to claim 1, wherein when the skin areas are extracted from the input image data, said area extractor extracts skin candidate areas from image data, converts color specification system of the image data for each of the skin candidate areas and extracts skin areas from the skin candidate areas based on the image data in the color specification system.

9. The image processor according to claim 1, wherein said area extractor comprises a divider which divides the image data into rectangle areas, and an area integrator which integrates the rectangle areas for each of the characteristic when the skin areas are extracted, wherein said area integrator integrates adjacent pixels if difference in hue between adjacent pixels is within a threshold determined for each skin type.

10. An image processing method, wherein characteristics of a plurality of skin colors are classified beforehand, the method comprising the steps of:

extracting skin areas from input image data according to the classification of the characteristics of a plurality of skin colors; and

correcting image data of each of the extracted skin areas according to the characteristics of the skin

color of each of the skin areas.

11. The image processing method according to claim 10, wherein said image correction step comprises the steps of:

preparing a histogram of hue of each of the
5 extracted skin areas;

changing the histogram to shift the center of gravity thereof to come close to center of gravity of a memory color of the skin color according to the characteristic of skin color of the each of the skin areas;

10 generating a correction curve for correcting the image data according to the modified histogram; and

correcting the image data in the skin area according to the correction curve.

12. A computer-readable storage medium storing a computer program comprising the steps of:

15 providing classification of characteristics of a plurality of skin colors;

extracting skin areas from input image data according to the classification of the characteristics of a plurality of skin colors; and
20

correcting image data of each of the extracted skin areas according to the characteristics of the skin color of the each of the skin areas.

13. The computer-readable storage medium according to
25 claim 12, wherein in said extracting step, the

characteristic of skin is determined according to average, dispersion and center of gravity obtained from a histogram of image data of the skin area.

14. The computer-readable storage medium according to claim 12, wherein in said correcting step, a histogram of hue of the extracted skin area is prepared, the histogram is modified to shift the center of gravity thereof to come close to center of gravity of a memory color of the skin color according to the characteristic of skin color of each of the skin areas, a correction curve for image data is generated according to the modified histogram, and the image data in the skin area is corrected according to the correction curve.

15. The computer-readable storage medium according to claim 14, wherein in said correcting step, a histogram of chroma of each of the extracted skin areas is prepared, the histogram is extended according to the characteristic of skin, and a correction curve for the image data is generated.

16. The computer-readable storage medium according to claim 15, wherein when the skin areas are extracted from the input image data, skin candidate areas are extracted from image data, color specification system of the image data is converted for each of the skin candidate areas and skin areas are extracted from the extracted skin candidate areas based on the image data in the color specification system.

17. The computer-readable storage medium according to claim 16, wherein in said extracting step, the image data are divided into rectangle areas, and the rectangle areas are integrated for each of the characteristic when the skin areas are extracted, wherein adjacent pixels are integrated if difference in hue between adjacent pixels is within a threshold determined for each skin type.

18. The computer-readable storage medium according to claim 12, wherein in said correcting step, a histogram of chroma of each of the extracted skin areas is prepared, the histogram is modified according to the characteristic of skin, and a correction curve for the image data is generated.

19. The computer-readable storage medium according to claim 12, wherein when the skin areas are extracted from the input image data, skin candidate areas are extracted from image data, color specification system of the image data is converted for each of the skin candidate areas and skin areas are extracted from the extracted skin candidate areas based on the image data in the color specification system.

20. The computer-readable storage medium according to claim 12, wherein in said extracting step, the image data are divided into rectangle areas, and the rectangle areas are integrated for each of the characteristic when the skin areas are extracted, wherein adjacent pixels are integrated if difference in hue between adjacent pixels is within a

threshold determined for each skin type.

ABSTRACT OF THE DISCLOSURE

Characteristics of a plurality of skin types have been classified, and skin areas are detected from image data according to the classification. The skin areas are extracted in two steps, first coarsely and next finely. Then, skin areas can be extracted at high speed. For each of the skin areas image data are corrected according to the characteristics of the skin area. Then, skin areas are corrected according to the skin type. Even when an image includes a plurality of persons having different skin characteristics, correction appropriate for each skin type is possible.

Fig. 1

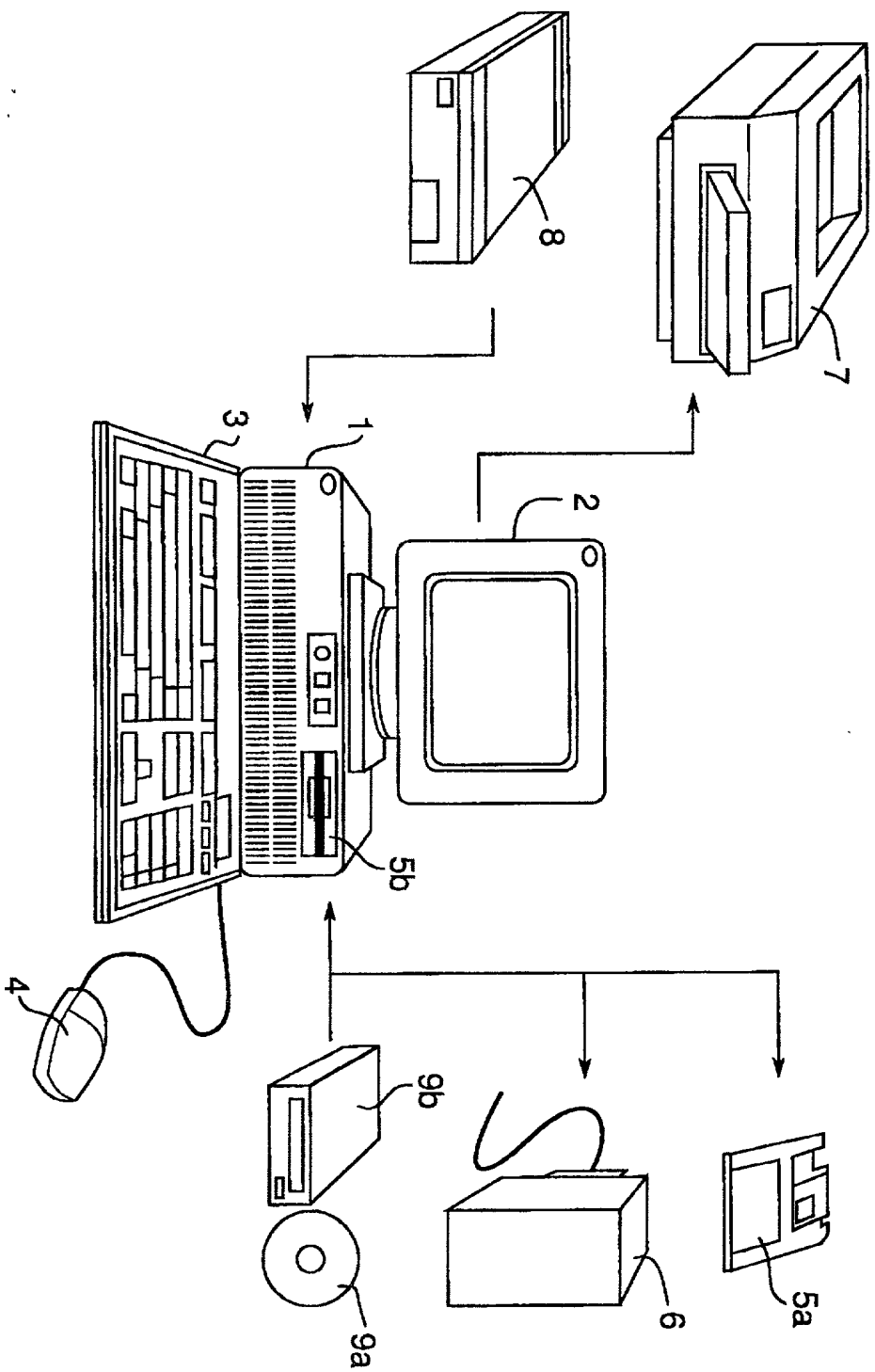


Fig.2

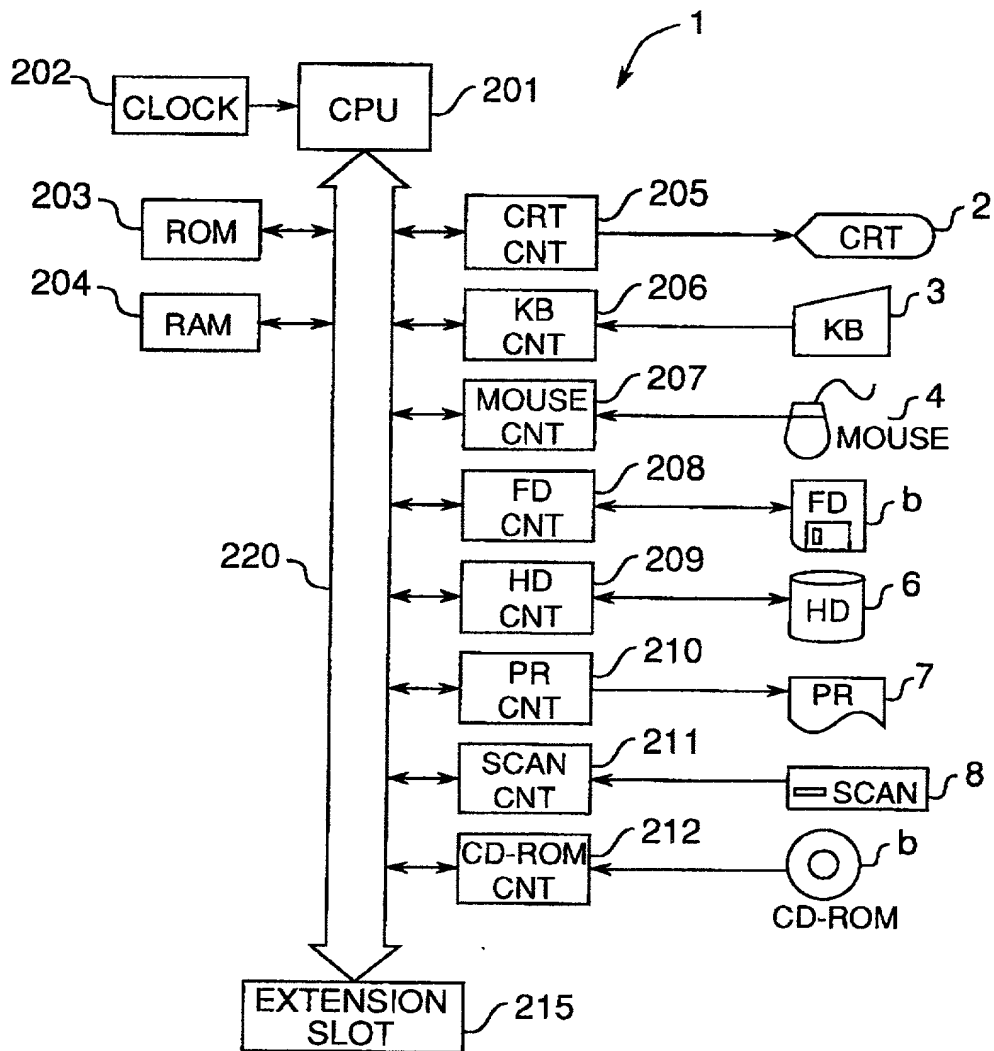


Fig.3

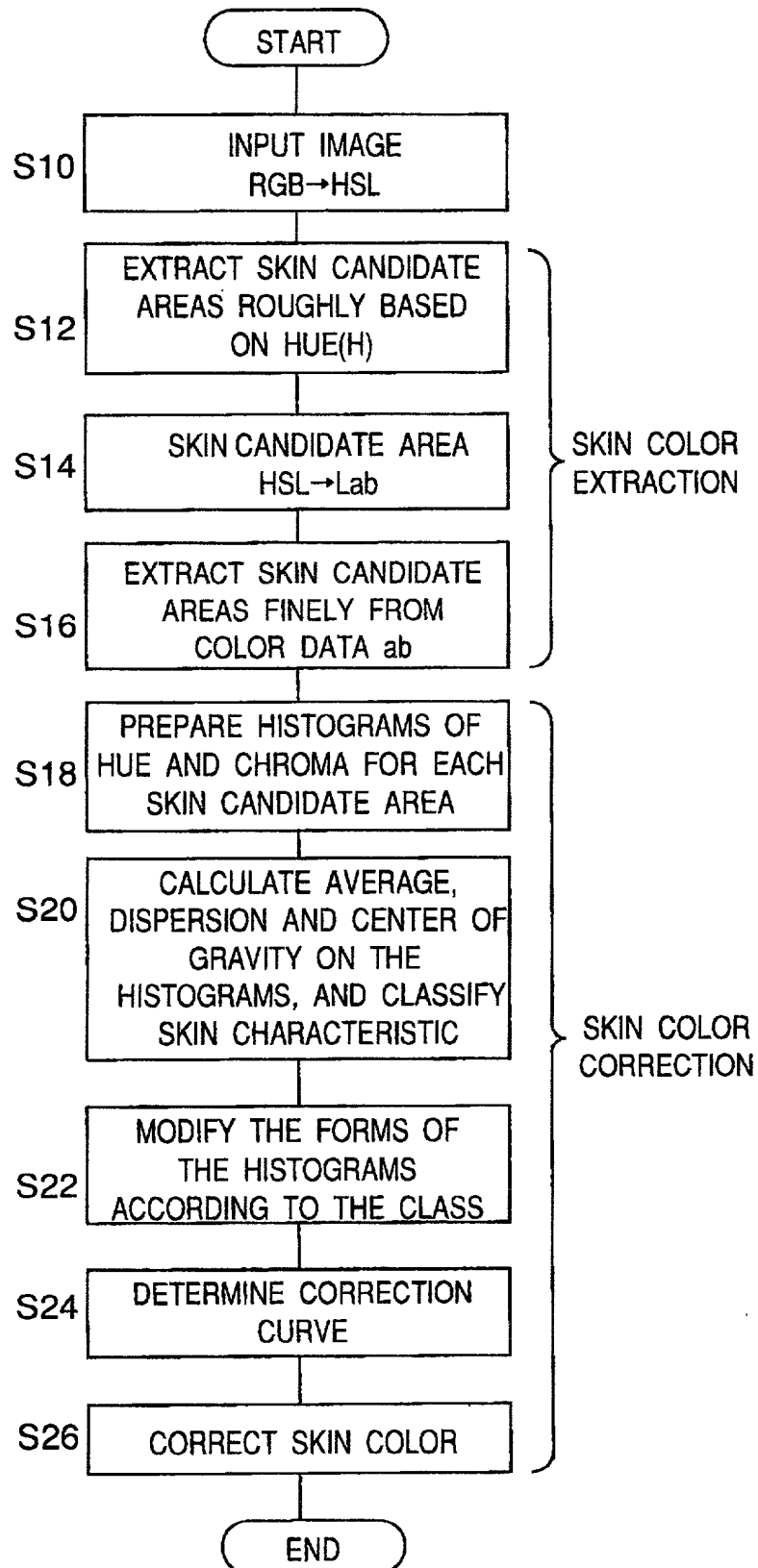


Fig.4

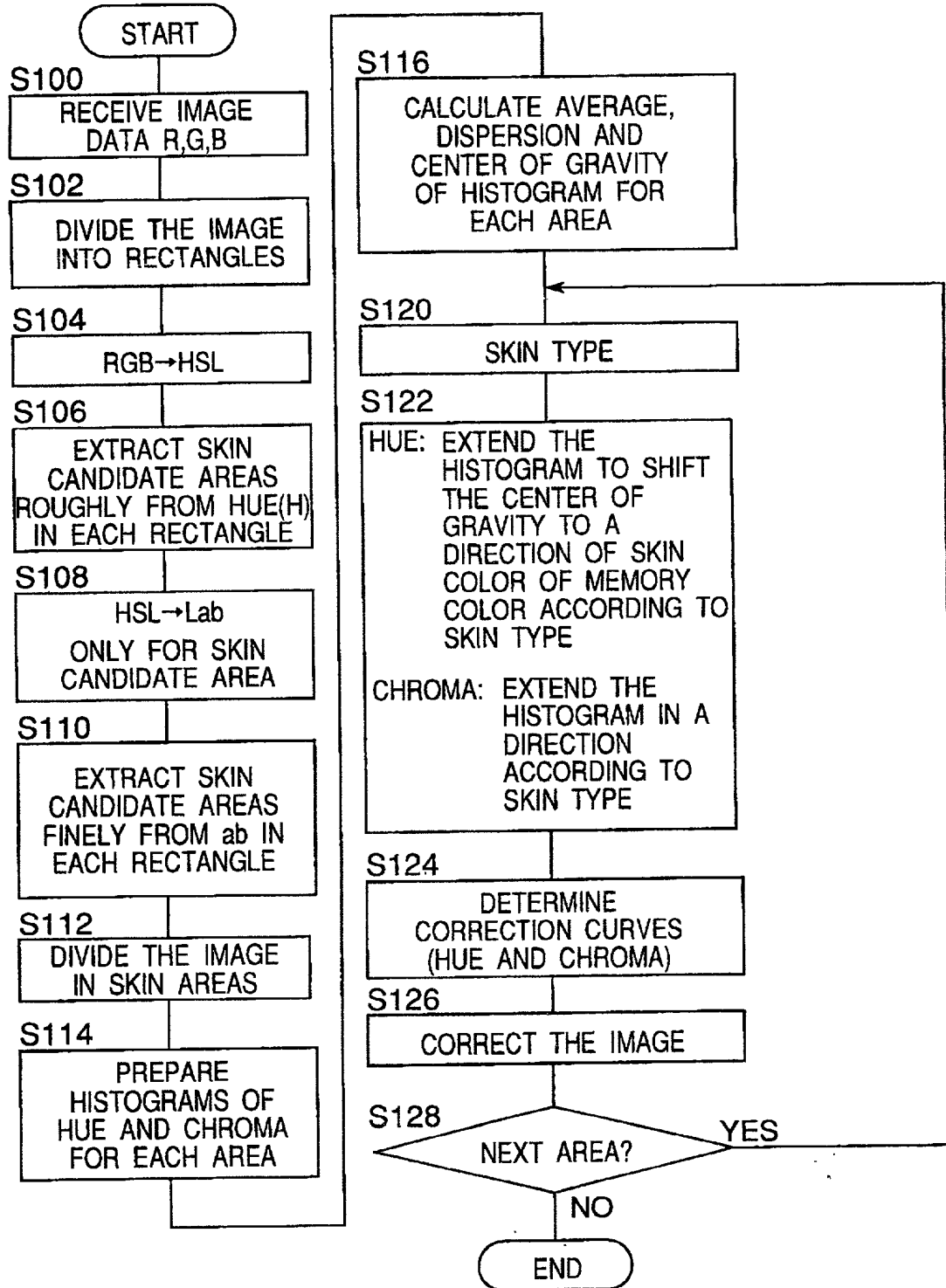


Fig.5

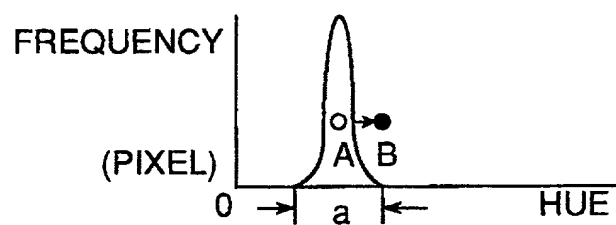


Fig.6

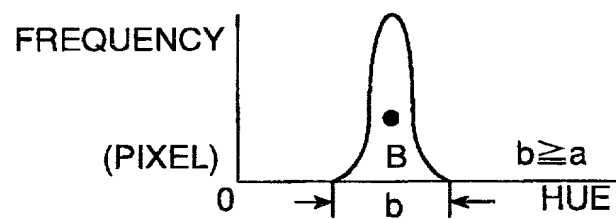


Fig.7

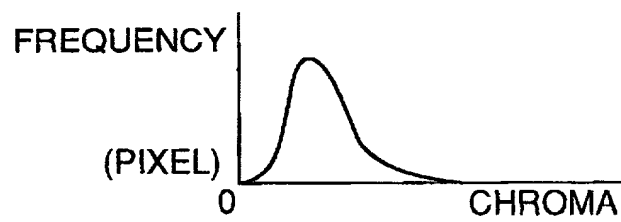


Fig.8

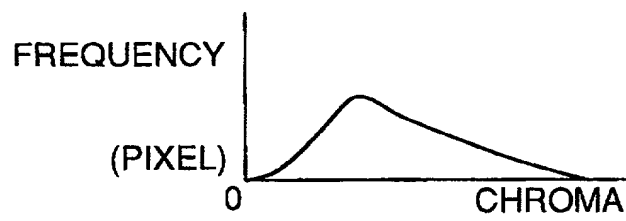
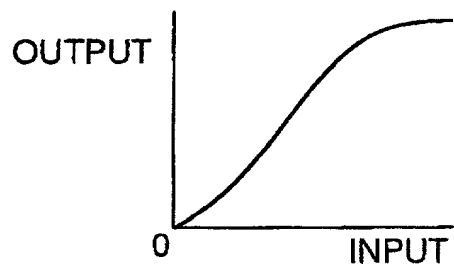


Fig.9



**COMBINED DECLARATION AND POWER OF ATTORNEY
FOR UTILITY PATENT APPLICATION**

Attorney's Docket No.

018775-795

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I BELIEVE I AM THE ORIGINAL, FIRST AND SOLE INVENTOR (if only one name is listed below) OR AN ORIGINAL, FIRST AND JOINT INVENTOR (if more than one name is listed below) OF THE SUBJECT MATTER WHICH IS CLAIMED AND FOR WHICH A PATENT IS SOUGHT ON THE INVENTION ENTITLED:

IMAGE PROCESSING FOR IMAGE CORRECTION

the specification of which

(check one)



is attached hereto;



was filed on _____ as

Application No. _____

and was amended on _____ ;
(if applicable)

I HAVE REVIEWED AND UNDERSTAND THE CONTENTS OF THE ABOVE-IDENTIFIED SPECIFICATION, INCLUDING THE CLAIMS, AS AMENDED BY ANY AMENDMENT REFERRED TO ABOVE;

I ACKNOWLEDGE THE DUTY TO DISCLOSE TO THE OFFICE ALL INFORMATION KNOWN TO ME TO BE MATERIAL TO PATENTABILITY AS DEFINED IN TITLE 37, CODE OF FEDERAL REGULATIONS, Sec. 1.56 (as amended effective March 16, 1992);

I do not know and do not believe the said invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to said application; that said invention was not in public use or on sale in the United States of America more than one year prior to said application; that said invention has not been patented or made the subject of an inventor's certificate issued before the date of said application in any country foreign to the United States of America on any application filed by me or my legal representatives or assigns more than twelve months prior to said application;

I hereby claim foreign priority benefits under Title 35, United States Code Sec. 119 and/or Sec. 365 of any foreign application(s) for patent or inventor's certificate as indicated below and have also identified below any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application(s) on which priority is claimed:

COMBINED DECLARATION AND POWER OF ATTORNEY

Attorney's Docket No.

018775-795

COUNTRY/INTERNATIONAL	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED
Japan	11-183444	29-06-99	YES <u>X</u> NO <u> </u>
			YES <u> </u> NO <u> </u>

I hereby appoint the following attorneys and agent(s) to prosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:

William L. Mathis	17,337	R. Danny Huntington	27,903	Gerald F. Swiss	30,113
Robert S. Swecker	19,885	Eric H. Weisblatt	30,505	Charles F. Wieland III	33,096
Platon N. Mandros	22,124	James W. Peterson	26,057	Bruce T. Wieder	33,815
Benton S. Duffett, Jr.	22,030	Teresa Stanek Rea	30,427	Todd R. Walters	34,040
Norman H. Stepno	22,716	Robert E. Krebs	25,885	Ronni S. Jillions	31,979
Ronald L. Grudziecki	24,970	William C. Rowland	30,888	Harold R. Brown III	36,341
Frederick G. Michaud, Jr.	26,003	T. Gene Dillahunt	25,423	Allen R. Baum	36,086
Alan E. Kopecki	25,813	Patrick C. Keane	32,858	Steven M. du Bois	35,023
Regis E. Slutter	26,999	Bruce J. Boggs, Jr.	32,344	Brian P. O'Shaughnessy	32,747
Samuel C. Miller, III	27,360	William H. Benz	25,952	Kenneth B. Leffler	36,075
Robert G. Mukai	28,531	Peter K. Skiff	31,917	Fred W. Hathaway	32,236
George A. Hovanec, Jr.	28,223	Richard J. McGrath	29,195		
James A. LaBarre	28,632	Matthew L. Schneider	32,814		
E. Joseph Gess	28,510	Michael G. Savage	32,596		

**21839**

and: _____

Address all correspondence to:

**21839**

PLATON N. MANDROS

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

P.O. Box 1404

Alexandria, Virginia 22313-1404

Address all telephone calls to: Platon N. Mandros at (703) 836-6620.

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FULL NAME OF SOLE OR FIRST INVENTOR	SIGNATURE	DATE
Hiroki YOSHIDA		
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FULL NAME OF SECOND JOINT INVENTOR, IF ANY	SIGNATURE	DATE
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